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Association Between Aging of the US Population and Heart Disease Mortality From 2011 to 2017

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Supplemental content

IMPORTANCE A deceleration in the rate of decrease of heart disease (HD) mortality between 2011 and 2014 has been reported. In the context of the rapid increase in the population of adults aged 65 years and older, extending the examination of HD mortality through 2017 has potentially important implications for public health and medical care.

OBJECTIVE To examine changes in the age-adjusted mortality rate and the number of deaths within subcategories of HD from 2011 to 2017 in conjunction with the change in the size of the US population during the same period.

DESIGN, SETTING, AND PARTICIPANTS In this quality improvement study, the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) data set was used to identify national changes in the US population aged 65 years and older and in the age-adjusted mortality rates and number of deaths that were listed with an underlying cause of HD, coronary heart disease (CHD), heart failure, and other HDs from January 1, 2011, to December 31, 2017.

MAIN OUTCOMES AND MEASURES Changes from 2011 to 2017 in the US population and in age-adjusted mortality rates and number of deaths that were listed with an underlying cause of HD, CHD, heart failure (both as an underlying and a contributing cause), and other HDs overall, by sex and race/ethnicity.

RESULTS The total size of this population of US adults aged 65 years and older increased 22.9% from 41.4 million to 50.9 million between January 1, 2011, and December 31, 2017, while the population of adults younger than 65 years increased by only 1.7%. During this period, the age-adjusted mortality rate decreased 5.0% for HD and 14.9% for CHD while increasing 20.7% for heart failure and 8.4% for other HDs. The number of deaths increased 8.5% for HD, 38.0% for heart failure, and 23.4% for other HDs while decreasing 2.5% for CHD. A total of 80% of HD deaths occurred in the group of adults aged 65 years and older.

CONCLUSIONS AND RELEVANCE The substantial increase in the growth rate of the group of adults aged 65 years and older who have the highest risk of HD was associated with an increase in the number of HD deaths in this group despite a slowly declining HD mortality rate in the general population. With the number of adults aged 65 years and older projected to increase an additional 44% from 2017 to 2030, innovative and effective approaches to prevent and treat HD, particularly the substantially increasing rates of heart failure, are needed.

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A 2016 study reported a marked deceleration in the rate of decrease of heart disease (HD) mortality between January 1, 2011, and December 31, 2014, compared with the rate of decrease between January 1, 2000, and December 31, 2011,[1] and variability in this pattern by HD subtype.[2] This report examines the association between combined patterns of HD mortality subtypes and demographic changes in the population, especially the increase in the number of adults aged 65 years and older and the number of deaths associated with HD in the United States.

Methods

In this quality improvement study, the number of deaths, mortality rates, and US population data between January 1, 2000, and December 31, 2017, were obtained from the Centers for Disease Control and Prevention Wide-Ranging Online Data for Epidemiologic Research (CDC WONDER) data set,[3,4] which includes underlying and contributing causes of death from death certificates filed in the 50 states and the District of Columbia. The World Health Organization[3] has defined the underlying cause of death as the disease or injury that initiated the series of events leading directly to death and a contributing cause of death as a disease or injury that can be considered a contributing factor leading to death. To categorize the underlying and contributing causes of death, we used codes from the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (*ICD-10*)[4] as follows: all HD (*ICD-10* codes I00-I09, I11, I13, and I20-I51), coronary heart disease (CHD; *ICD-10* codes I20-I25), heart failure (HF; *ICD-10* code I50), and all other HDs (*ICD-10* codes I00-I09, I11, I13, I26-I49, and I51). The population projection for 2030 was obtained from the US Census Bureau.[5] The institutional review board of Kaiser Permanente Northern California determined this study to be exempt from review because it used a deidentified government-issued public-use data set and therefore did not represent human subjects research. Mortality rates were age adjusted using the direct method, with data from the 2000 US census used to define the standard population.[6] We performed further analyses to address issues regarding coding of HF by exploring HF that was listed as the underlying cause of death among those who died suddenly and by restricting the main analysis to adults younger than 85 years.

Results

The total US population of adults aged 65 years and older increased from 41.4 million in 2011 to 50.9 million in 2017 (22.9% total increase; 3.5% annualized increase; eTable 1 in the Supplement).[3] The population of adults aged 65 years and older is projected to increase to 73.1 million by 2030 (43.8% total increase; 2.8% annualized increase from 2017-2030).[5] Population increases by sex and race/ethnicity from 2011 to 2017 for the group of adults aged 65 years and older included increases of 25.8% in men, 20.7% in women, 18.9% in adults with white ancestry, 51.3% in adults with Asian/Pacific Island an-

Key Points

Question Was the rapid increase in the number of adults aged 65 years and older from 2011 to 2017 associated with mortality related to heart disease?

Findings In this quality improvement study of all US adults aged 65 years and older, the total size of this population increased from 41.4 million to 50.9 million between January 1, 2011, and December 31, 2017. Overall, the number of deaths increased by 8.5% for heart disease and 38.0% for heart failure, most of which were in the 65 years and older age group.

Meaning With the population of adults aged 65 years and older projected to increase an additional 44% from 2017 to 2030, innovative and effective approaches to prevent and treat heart disease are needed.

cestry, 41.6% in adults with Hispanic ancestry, 30.8% in adults with black ancestry, and 41.9% in adults with American Indian/Alaskan native ancestry. The population younger than 65 years increased by 1.7%.

Deceleration in the rate of decrease of HD mortality continued through 2017, with the age-adjusted HD mortality rate decreasing only 5.0% (<1% annualized decrease) from 2011 to 2017 (**Table 1**; **Figure**). An estimated 80% of HD deaths occurred in adults aged 65 years and older (80% CHD, 92% HF, and 76% other HDs). The substantial increase in the growth rate of the adult population aged 65 years and older, who are at highest risk of HD, combined with the slow decrease in HD mortality, was associated with an increasing number of HD deaths since 2011 (n = 50 880; 8.5% total increase) after a substantial decrease in HD deaths between 2000 and 2011. The number of HD deaths increased in all subgroups.

The age-adjusted mortality rate associated with CHD continued to decrease, with a 14.9% decrease (2.7% annualized decrease) from 2011 to 2017 (Table 1; Figure). The number of CHD deaths decreased but at a much slower rate (2.5% total decrease from 2011-2017) and was virtually unchanged from 2015 to 2017 (0.2% decrease). The mortality rate decreased in all subgroups, and the number of deaths increased in women and white adults while decreasing in men and all other race/ethnicity groups.

The age-adjusted mortality rate for HF listed as the underlying cause increased substantially (20.7% total increase; 3.2% annualized increase) from 2011 to 2017, which, when combined with the 22.9% increase in the number of adults aged 65 years and older, resulted in a 38% increase in the number of deaths with HF as the underlying cause (**Table 2**; Figure). Increases in both the mortality rate and the number of deaths associated with HF increased in all subgroups. The substantial increase in the mortality rate and number of deaths with HF listed as the underlying cause was consistent with patterns that occurred for HF listed as a contributing cause (Table 2; Figure). The age-adjusted mortality rates decreased from 2000 to 2011 for HF as the underlying cause and from 2000 to 2012 for HF as a contributing cause, and the rates increased thereafter for both HF as the underlying cause and HF as a contributing cause through 2017. Similarly, the number

Table 1. Age-Adjusted Mortality Rates and Number of Deaths Associated With All Heart Disease and Coronary Heart Disease as Underlying Cause of Death, 2011-2017[a]

Characteristic	All Heart Disease, No.			Coronary Heart Disease, No.		
	2011	2017	Percent Change	2011	2017	Percent Change
Total population						
Mortality rate	173.7	165.0	−5.0	109.2	92.9	−14.9
Total deaths	596 577	647 457	8.5	375 295	365 914	−2.5
Deaths by age, y						
<65	121 453	128 365	5.7	76 162	74 364	−2.4
≥65	475 097	519 052	9.3	299 114	291 526	−2.5
Men						
Mortality rate	218.1	209.0	−4.2	145.6	126.8	−12.9
Total deaths	308 398	347 879	12.8	206 908	213 295	3.1
Deaths by age, y						
<65	84 707	88 606	4.6	56 046	54 267	−3.2
≥65	223 669	259 248	15.9	150 846	159 010	5.4
Women						
Mortality rate	138.7	129.6	−6.6	81.0	66.0	−18.5
Total deaths	288 179	299 578	4.0	168 387	152 619	−9.4
Deaths by age, y						
<65	36 746	39 759	8.2	20 116	20 097	−0.1
≥65	251 428	259 804	3.3	148 268	132 516	−10.6
White						
Mortality rate	175.6	168.9	−3.8	111.1	95.5	−14.0
Total deaths	482 979	508 485	5.3	305 486	288 019	−5.7
Deaths by age, y						
<65	84 281	85 036	0.9	55 682	52 098	−6.4
≥65	398 682	423 429	6.2	249 792	235 907	−5.6
Asian/Pacific Islander						
Mortality rate	93.8	85.5	−8.8	63.2	54.0	−14.6
Total deaths	11 406	15 490	35.8	7712	9824	27.4
Deaths by age, y						
<65	2450	2962	20.9	1647	1861	13.0
≥65	8956	12 528	39.9	6065	7963	31.3
Hispanic						
Mortality rate	123.9	114.1	−7.9	84.2	70.7	−16.0
Total deaths	30 385	39 402	29.7	20 326	24 236	19.2
Deaths by age, y						
<65	8302	10 440	25.8	5068	6044	19.3
≥65	22 083	28 956	31.1	15 258	18 189	19.2
Black						
Mortality rate	219.3	208.0	−5.2	127.9	107.2	−16.2
Total deaths	67 595	78 161	15.6	38 928	40 222	3.3
Deaths by age, y						
<65	24 892	27 950	12.3	12 796	13 216	3.3
≥65	42 698	50 208	17.6	26 130	27 005	3.3
American Indian/Alaskan native						
Mortality rate	161.0	151.4	−6.0	104.8	87.8	−16.2
Total deaths	2805	3472	23.8	1836	2032	10.7
Deaths by age, y						
<65	1073	1237	15.3	685	685	0
≥65	1732	2235	29.0	1151	1347	17.0

[a] Age-adjusted mortality rates are per 100 000 people.

Figure. Total Mortality Rates and Number of Deaths, 2000 to 2017
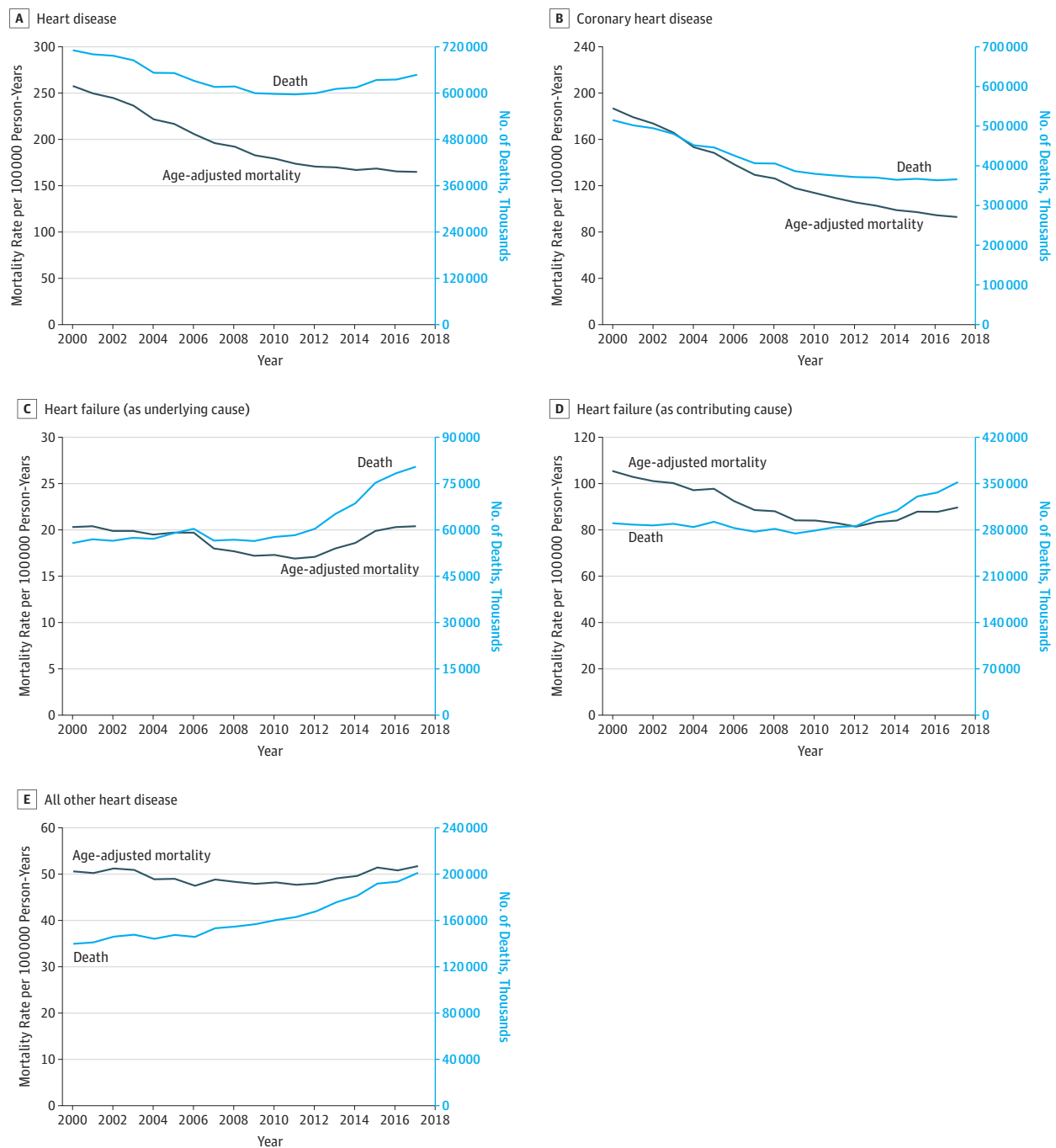
A, Heart disease. B, Coronary heart disease. C, Heart failure as underlying cause. D, Heart failure as contributing cause. E, All other heart disease.

of deaths associated with either HF as the underlying cause or HF as a contributing cause decreased from 2000 to 2009, and they increased steadily thereafter to 80 480 and 352 119, respectively, in 2017.

Increases in the age-adjusted rate of other HDs and the number of deaths from 2011 to 2017 were 8.4% and 23.4%, respectively (Figure; eTable 2 in the Supplement). The mortality rate increased in men and all race/ethnicity groups with the

exception of adults with Asian/Pacific Island ancestry, while the number of deaths increased in all subgroups.

We also examined the distribution of HF and CHD listed as an underlying or contributing cause of death when both were present. From 2011 to 2017, there were 513 deaths with HF listed as the underlying cause and CHD listed as a contributing cause compared with 518 692 deaths with CHD listed as the underlying cause and HF listed as a contributing cause (eTable 3 in

Table 2. Age-Adjusted Mortality Rates and Number of Deaths Associated With Heart Failure as Underlying and Contributing Cause of Death, 2011-2017[a]

Characteristic	Heart Failure Underlying Cause, No.			Heart Failure Contributing Cause, No.		
	2011	2017	Percent Change	2011	2017	Percent Change
Total population						
Mortality rate	16.9	20.4	20.7	83.0	89.7	8.1
Total deaths	58 309	80 480	38.0	284 388	352 119	23.8
Deaths by age, y						
<65	4497	6796	51.1	26 488	35 434	33.8
≥65	53 811	73 682	36.9	257 895	316 677	22.8
Men						
Mortality rate	18.7	23.3	24.6	97.2	106.7	9.8
Total deaths	24 609	36 824	49.6	129 635	170 485	31.5
Deaths by age, y						
<65	2717	4317	58.9	16 178	22 048	36.3
≥65	21 891	32 506	48.5	113 453	148 433	30.8
Women						
Mortality rate	15.6	18.3	17.3	73.0	77.2	5.8
Total deaths	33 700	43 656	29.5	154 753	181 634	17.4
Deaths by age, y						
<65	1780	2479	39.3	10 310	13 386	29.8
≥65	31 920	41 176	29.0	144 442	168 244	16.5
White						
Mortality rate	17.5	21.3	21.7	85.8	93.7	9.2
Total deaths	49 605	66 080	33.2	252 685	306 745	21.4
Deaths by age, y						
<65	2821	3929	39.3	19 175	24 778	29.2
≥65	46 783	62 150	32.8	233 506	281 961	20.8
Asian/Pacific Islander						
Mortality rate	6.4	8.0	25.0	38.3	40.0	4.4
Total deaths	714	1385	94.0	4399	7043	60.1
Deaths by age, y						
<65	55	114	107.3	503	849	68.8
≥65	659	1271	92.9	3973	6341	41.7
Hispanic						
Mortality rate	10.1	11.8	16.8	54.6	58.0	6.2
Total deaths	2233	3780	69.3	12 385	18 994	53.4
Deaths by age, y						
<65	301	533	77.1	1914	3144	64.3
≥65	1932	3247	68.1	10 471	15 850	51.4
Black						
Mortality rate	19.1	24.6	28.8	88.1	99.2	12.6
Total deaths	5492	8751	59.3	25 649	35 828	39.7
Deaths by age, y						
<65	1277	2144	67.9	6454	9254	43.4
≥65	4215	6607	56.7	19 194	26 573	38.4
American Indian/Alaskan native						
Mortality rate	14.9	16.6	11.4	85.7	87.3	1.9
Total deaths	222	339	52.7	1333	1869	40.2
Deaths by age, y						
<65	36	52	44.4	295	412	39.7
≥65	186	287	54.3	1333	1457	9.3

[a] Age-adjusted mortality rates are per 100 000 person-years.

the Supplement). Nearly all deaths in patients with CHD and HF were coded with an underlying cause of CHD.

Two *ICD-10* categories, *ICD-10* code I46 (cardiac arrest) and *ICD-10* code I49.0 (ventricular fibrillation or flutter), were likely to include a high proportion of adults who died suddenly. From 2011 to 2017, the annual number of deaths with HF as the underlying cause with a contributing cause of cardiac arrest or ventricular fibrillation or flutter increased by 3460 from 8634 to 12 094 deaths (eTable 4 in the Supplement), which represented 15.6% of the total increase in deaths with HF listed as the underlying cause and an estimated 2.9% of all deaths with cardiac arrest or ventricular fibrillation or flutter listed as a contributing cause.

In an analysis restricted to those younger than 85 years, the age-adjusted HF mortality rate and the number of HF deaths increased by 42.6% and 23.4%, respectively, from 2011 to 2017, both of which exceeded the increases for the entire age range (eTable 5 in the Supplement).

Discussion

The deceleration in the decrease of the HD mortality rate, which was previously reported for the 2011 to 2014 period compared with the 2000 to 2011 period, continued through 2017. Combined with the rapid growth rate of the population of adults aged 65 years and older, this deceleration was associated with an 8.5% increase (n = 50 880) in the number of HD deaths. The probable reasons for the deceleration in the decrease of the HD mortality rate were discussed in an earlier publication, with the most notable factors being the substantial increases in obesity and diabetes rates that began in the mid-1980s.[1] For HF, the rapid population growth in the group of adults aged 65 years and older, combined with a substantial increase in the HF mortality rate, were associated with a 38% increase in the number of deaths with HF listed as the underlying cause. Between 2015 and 2030, the prevalence of HF nationally was projected to increase by 37% (57% in those aged ≥65 years).[7] If separated from all HDs, HF would be the eighth leading cause of death in the United States.

Although we could not discern mortality associated with type of HF in the current data set because HF with preserved ejection fraction was not coded, a report from the American Heart Association entitled "Get With the Guidelines Heart Failure,"[8] which was linked to Medicare data from adults aged 65 years and older, reported that among patients admitted for HF between 2005 and 2009, 46% had HF with preserved ejection fraction and 46% had HF with reduced ejection fraction, both with 5-year mortality rates of 75%.[9]

The emergence of HF with preserved ejection fraction as a highly prevalent HF phenotype is notable because, to our knowledge, no proven disease-modifying therapies currently exist. Our data regarding the 2011 to 2017 increases in mortality associated with HF and the racial/ethnic disparities in HF-related mortality, with the highest mortality rates observed among black adults, are consistent with other published findings.[2,10]

Limitations

The potential exists for misclassification of death certificate coding of HF because of the inability to access and use clinical information obtained before death. Our results suggest that the potential miscoding of HF in the settings of cardiac arrest or ventricular fibrillation or flutter and in adults who are 85 years and older is unlikely to change our results significantly. Additional limitations include the possibility that the increasing use of echocardiography, which identifies some patients with occult HF, and the increased recognition of HF with preserved ejection fraction may be associated with increased coding of HF on death certificates. Our analyses, especially the comparisons between mortality with HF listed as the underlying cause and HF listed as a contributing cause, highlight the heterogeneous cardiac function characteristics and multiple potential etiologies of HF and the limitations in current data surveillance at a national level. National data are lacking regarding the type of HF, the measurement of adherence to guideline-directed medical therapy, the consequences of the Medicare Hospital Readmissions Reduction Program, and finally, the adverse effects of social factors associated with health in at-risk groups, all of which may be factors associated with the increase in HF mortality.

Conclusions

In summary, despite a decrease in age-adjusted mortality associated with HD and CHD, the increasing rates of death associated with HF and other forms of HD, coupled with the continued rapid increase in the population of adults aged 65 years and older, seem to be associated with a steady, substantial increase in the total number of HD deaths. The projected 44% increase in the number of adults aged 65 years and older from 2017 to 2030 can be expected to create challenges for the capacity of public health and medical care efforts to prevent and manage HD. Innovative and effective approaches for surveillance, prevention, and treatment are needed to address the expanding burden of HD mortality, particularly for the substantially increasing rates of HF.

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